REMARKS

Amendments have been made to the drawings and specification to make them consistent. Changes to the drawings are marked in red. No new matter has been added.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page(s) is captioned "**Version With Markings To Show Changes Made.**"

Respectfully submitted,

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Version With Markings To Show Changes Made

In the Specification:

The paragraph beginning on page 3, line 13 has been amended as set forth below:

Figure 2A shows the block diagram of the Multi-windowing technique for thresholding an image using local image properties.

The paragraph beginning on page 3, line 15 has been amended as set forth below:

Figure [2A] 2B illustrates the image quality of a thresholded image controlled by the input threshold parameters (contrast threshold (CT), intensity threshold (IT)).

The paragraph beginning on page 3, line 18 has been amended as set forth below:

Figure [2B] 2C illustrates the relationship of the two input parameters (contrast threshold, intensity threshold) and the sensitivity of thresholding.

The paragraph beginning on page 3, line 20 has been amended as set forth below:

Figure 3A shows the image processing steps of automatic image quality inspection for a bitone image.

The paragraph beginning on page 3, line 22 has been amended as set forth below:

Figure [3A] 3B shows the neighborhood operation of binary image dilation.

The paragraph beginning on page 3, line 24 has been amended as set forth below:

Figure [3B] 3C is an example of noise dot structures before image dilation in a binary image.

The paragraph beginning on page 3, line 26 has been amended as set forth below:

Figure [3C] 3D is the noise dot structures of Figure 3B after image dilation.

The paragraph beginning on page 3, line 28 has been amended as set forth below:

Figure [3D] 3E is the image processing block diagram of noise feature extraction.

The paragraph beginning on page 3, line 30 has been amended as set forth below:

Figure [3E] 3F is an example of noise feature calculation in a binary image.

The paragraph beginning on page 4, line 1 has been amended as set forth below:

Figure 4A shows the block diagram of the image processing for automatic image quality correction.

The paragraph beginning on page 4, line 3 has been amended as set forth below:

Figure [4A] 4B shows the block diagram of the image processing for the multiple adaptive image thresholding.

The paragraph beginning on page 4, line 5 has been amended as set forth below:

Figure [4B] 4C is the table containing the calculated noise levels for different thresholded images produced by various input parameters (contrast threshold [(GT)] (CT), intensity threshold (IT)).

The paragraph beginning on page 4, line 8 has been amended as set forth below:

Figure [4C] 4D is a flow chart of noise level analysis in finding the optimal contrast threshold and intensity threshold.

The paragraph beginning on page 4, line 10 has been amended as set forth below:

Figure [4D] 4E is the first example of noise index distribution (R([GT]CT,IT)) with constant intensity threshold (IT) at 70 and multiple contrast thresholds [(GT)] (CT) varied from 60 to 15.

The paragraph beginning on page 4, line 13 has been amended as set forth below:

Figure [4E] 4F is the second example of noise index distribution (R([GT]CT,IT)) with constant intensity threshold (IT) at 70 and multiple contrast thresholds [(GT)] (CT) varied from 60 to 15.

The paragraph beginning on page 4, line 16 has been amended as set forth below:

Figure [4F] 4G is the third example of noise index distribution (R([GT]CT,IT)) with constant intensity threshold (IT) at 70 and multiple contrast thresholds [(GT)] (CT) varied from 60 to 15.

The paragraph beginning on page 4, line 19 has been amended as set forth below:

Figure [4G] 4H is an example of noise index distribution (R([GT]CT,IT)) with constant intensity threshold (IT) at 60 and multiple contrast thresholds [(GT)] (CT) varied from 70 to 220.

The paragraph beginning on page 4, line 22 has been amended as set forth below:

Figure [4H] 4I is an example of noise index distribution (R([GT]CT,IT)) with constant intensity threshold (IT) at 60 and multiple contrast thresholds [(GT)] (CT) varied from 70 to 220.

The paragraph beginning on page 5, line 11 has been amended as set forth below:

The multi-windowing technique for thresholding an image using local image properties as described in U.S. Patent No. 5,583,659, the disclosure of which is hereby incorporated by reference, is applied to convert a gray scale image into a binary image. The thresholding technique calculates the threshold value for every pixel in an image based on the local image properties surrounding the pixel. The threshold value is then applied to turn the gray value of a pixel into bi-level value (black or white). The block diagram of the thresholding technique is summarized in Figure 2<u>A</u>. The operation of the technique requires a user to supply a contrast threshold value (CT) and an intensity threshold value (IT) as shown in Figure [2A] <u>2B</u>. The image quality of a thresholded image is determined by the input of the two threshold values (CT and IT). A thresholded image (CT, IT) as shown in Figure [2A] <u>2B</u> means that the image quality of a thresholded image is a function of (CT, IT). The image quality of a thresholded image is evaluated by two factors: text readability (no image information loss) and smoothness of the white background (noise free on image background). The CT value controls the sensitivity of detecting thin, light text and line arts, and the it value accounts for the threshold of a uniform gray region. Assume that the CT value is normalized to the values in the range of 0 and 100 and the it value is between 0 and 255 as shown in Figure [2B] <u>2C</u>. The CT value is often chosen to be sensitive enough for extracting all image information such as light text, thin lines, ... etc., and the IT value is set to turn light gray uniform region into white background. The threshold values at (CT=60, IT=90) as shown in Figure [2B] <u>2C</u> is considered as an appropriate setup to extract all image information details. However, the setup of the threshold values at (CT=60, IT=90) may result in too sensitive for some documents due to the roughness of document papers and results in generating unwanted speckle noises in background of the thresholded images. The following section describes the method of automatic image noise inspection.

The paragraph beginning on page 6, line 12 has been amended as set forth below:

Figure 3<u>A</u> is the processing steps of detecting noise level for a thresholded image. A binary image dilation operation is applied to the binary image (B) and generates a new binary image (B1). Three noise features are

measured from the dilated binary image (B1). The normalized noise area (R) is taken as the image noise index (INI) of the binary image (B). The detailed description of the processing steps as shown in Figure 3A is stated in the following.

The paragraph beginning on page 6, line 18 has been amended as set forth below:

Assume that black pixel is marked with "1" and white pixel is marked with "0" in a binary image. The image dilation operation is to expand the region of black dots by a local neighborhood operation as shown in Figure [3A] 3B. The center pixel "o" at the output is set to "0" only when all neighboring pixel X_I in a 3x3 window, where I=1, ...8, are matched with the 3x3 zero mask. Otherwise, the center pixel "o" at the output is marked with black pixel, "1". The dilation operation is required because in some documents the text is printed with dot-matrix. The dilation operation connects the adjacent small dots into line segments so that the noise dots and the dots belonging to dot-matrix characters becomes distinguishable. A graphical example is illustrated in Figure [3B] 3C and Figure [3C] 3D. Figure [3B] 3C displays a binary image before image dilation. The number and size of the black dots in the left-handed side of the image is identical to the one in the right-handed side. If the number (or the area) of the noise dots is taken as a feature to evaluate level of noise, the feature will fail to differentiate the image patterns in both sides. However, after image dilation is applied, the original dotted pattern is turned into two straight line segments in the left-handed side as shown in Figure [3C] 3D. The dispersed noise patterns in the right handed side of the image stays the same except the enlarged noise dots. Hence, the number of noise dots becomes a useful feature in extracting real noise dots in the evaluation of noise level in the dilated binary image.

The paragraph beginning on page 7, line 6 has been amended as set forth below:

The randomly, distributed small dots which contain no image information in a binary image are defined as noise. The noise measurement

requires counting the number and the area of the small dots in a binary image. Figure [3D] 3E depicts the processing steps of noise measurement on the dilated binary image. First, it applies to a contour tracing method (see reference in U.S. Patent No. 5,974,199, the disclosure of which is hereby incorporated by reference) to extract the outline of every object in the dilated binary image. The contour pixels are extracted either in a sequence of clockwise or counterclockwise. The contours extracted in the order of clockwise are the outer contour (or black object contours), and the contours extracted in the order of counterclockwise are the inner contours (or white object contours). A size threshold (T_s) is applied to reject the large contour components whose size is too large to be considered as noise dots. The numbers of the remaining small contours are counted for black noise dots (NB) and white noise dots (NW), respectively, and the total noise area (NA) for black noise dots is calculated. The normalized noise area (R) is the ratio of NA value over the document area (DA) and is taken as the image noise index (INI). The NB and NW values are used to differentiate the white background from the black background. When the NB is greater than the NW, it indicates that the image has a white background. A large NW value then indicates that the background is black. This occurs when there is a con-tone image or large dark gray area existed in the document. Figure [3E] 3F is an example of the calculation of noise features. There are 20 black noise dots counted. That is that NB equals to 20. The number of white noise dots (NW) is counted as 10. Assume that the average area of each noise is calculated as Na, then the total noise area (NA) is 20 times Na and the image noise index (INI) is equal to NA/DA.

The paragraph beginning on page 8, line 6 has been amended as set forth below:

Figure 4A shows the block diagram of image processing for automatic image quality correction. A multiple adaptive image thresholding process is applied to produce (N+M) binary images by orderly change of the N different contrast and the M different intensity threshold parameters. The noise level of every binary image in the (N+M) thresholded image is calculated, respectively. The optimal threshold parameters is obtained from the (N+M) pair

of threshold values by analyzing the correlation of the (N+M) noise levels and the (N+M) pairs of contrast and intensity thresholds.

The paragraph beginning on page 8, line 14 has been amended as set forth below:

The basic processing steps of the multiple adaptive thresholding are the same as the one in Figure 2A except with the multiple input of threshold values (CT, IT). The input (CT, IT) values are changed with 5 units decrement of CT and 30 units increment of IT in order of (60,70), (55,70), (50,70), (45,70), (40,70), (35,70), (30,70), (25,70), (20,70), (15,70), (60,100), (60,130), (60,160), (60,190) and (60,220). The 15 pairs of threshold values are fed into the adaptive thresholding process sequentially and generate 15 different binary images. By applying the process of noise feature extraction to the 15 different images separately as shown in Figure 3A, there are 15 noise values, R(CT,IT), calculated and listed in Figure [4B] 4C. Figure 4C shows noise levels at various combinations of (CT, IT).

The paragraph beginning on page 8, line 24 has been amended as set forth below:

The objective of correlation analysis of noise and (CT,IT) is to identify the threshold values (CT, IT) which will be used in the adaptive thresholding process in generating least background noises while retaining all image information in a thresholded image. Figure [4C] 4D is the block diagram of the data analysis of selecting the optimal threshold values. First, scanning through the set of noise values, R(CT(I),70), where I=1,...,10, if the condition (A): R(CT(I),70)>Rth for all CT(I), is met, where the Rth is a predefined noise threshold value (Rth) as shown in Figure [4D] 4E. This indicates that the noise levels of all thresholded images are high and unrelated to the change of contrast threshold. Hence, it requires the change of intensity threshold (IT) in search of the optimal intensity threshold. On the other hand, if the condition (A) fails, it requires the change of the contrast threshold (CT) in search of the optimal contrast threshold.

The paragraph beginning on page 9, line 5 has been amended as set forth below:

In the search of optimal contrast threshold, if the condition (B) : all of the noise values, R(CT(I),70), I=1, …,10, are smaller than the noise threshold (Rth) as shown in Figure [4D] 4E, it indicates that the starting threshold setting at (CT,IT) = (60,70) generates little background noises and the final threshold values (CTF,ITF) = (60,70) are taken as the optimal threshold values. Otherwise, by examining the array of R(CT(I), 70) data, if the condition [(B)] (C) : R(CT(I), 70)>R(CT(I+1), 70), I-1,…, 9, is satisfied, the final threshold values (CTF,ITF) = (CT(I), 70) is selected at where the CT(I) meets the condition: R(CT(I), 70)<Rth and R(CT(I+1), 70)>Rth. As the example shown in Figure [4E] 4F, the CT(I) value is selected at 35 and the final threshold values (CTF,ITF) = (35, 70). If the test of the condition [(B)] (C) fails, the final threshold values (CTF,ITF) = (CT(I), 70) is selected at where the CT(I) meets the condition: R(CT(I), 70)<R(CT(I-1), 70). As the example shown in Figure [4F] 4G, the CT(I) value is selected at 40 and the final threshold values (CTF,ITF) = (40, 70).

The paragraph beginning on page 9, line 19 has been amended as set forth below:

In the search of optimal intensity threshold, if the condition [(C)] (D) : R(60,IT(J))>Rth for all IT(J),J=1,…,6, is met, it indicates that the noise levels of all thresholded images are high and unrelated to the change of intensity threshold as the example shown in Figure [4G] 4H. The final threshold values (CTF,ITF) is set at (60, 70) which is the starting setup. This implies that there is no optimal threshold values detected and the final threshold values are assigned with the starting setting, (CTF,ITF) = (60, 70). On the other hand, if the test of the condition [(C)] (D) fails, the (CTF,ITF) = (60,IT(J)) is selected at where R(60, IT(J-1))>Rth and R(60, IT(J))<Rth. As the example shown in Figure [4H] 4I, the IT(J) value is selected at 130. This indicates the intensity threshold at IT(J-1) = 100 is close to the background intensity and it is incapable of thresholding the intensity levels of background pixels and results in generating large amount of background noises.

J= \ I=		1	2	3	4	5	6	7	8	9	10
	CT(I) / IT(J)	60	55	50	45	40	35	30	25	20	15
1	70	R(60,70)	R(55,70)	R(50,70)	R(45,70)	R(40,70)	R(35,70)	R(30,70)	R(25,70)	R(20,70)	R(15,70)
2	100	R(60,100)									
3	130	R(60,130)									
4	160	R(60,160)									
5	190	R(60,190)									
6	220	R(60,220)									

FIG. 4C

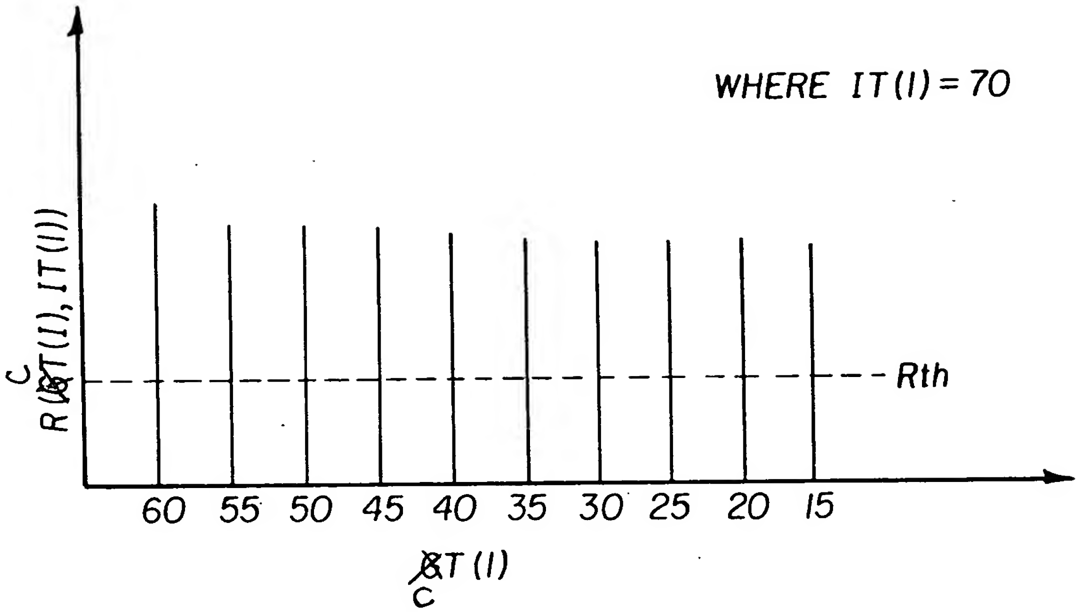
WHERE IT(I) = 70
R(CT(I), IT(I))
Rth
60 55 50 45 40 35 30 25 20 15
CT(I)

FIG. 4E

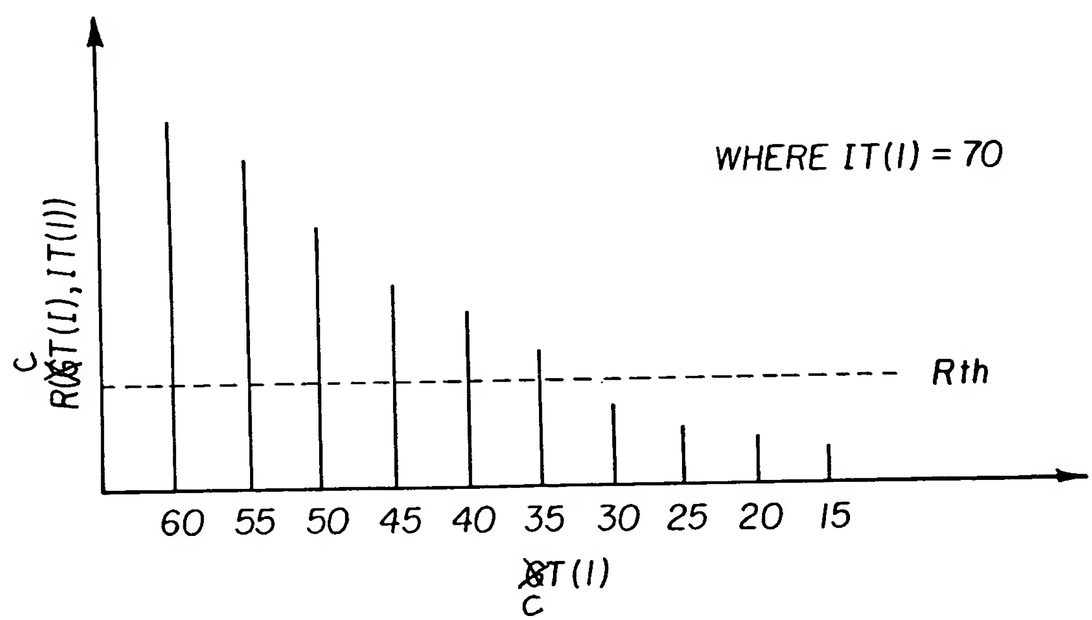
WHERE IT(I) = 70
R(CT(I), IT(I))
Rth
60 55 50 45 40 35 30 25 20 15
CT(I)

FIG. 4F

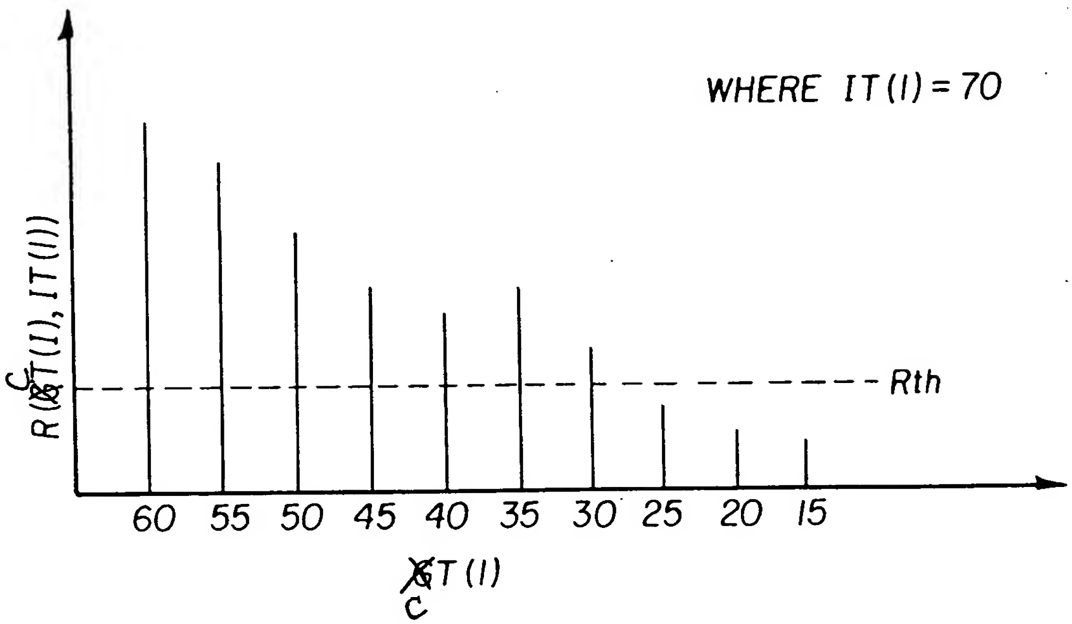
WHERE IT(I)=70
R(~~X~~ C T(I), IT(I))
Rth
60
55
50
45
40
35
30
25
20
15
~~X~~ C T(I)

FIG. 4G

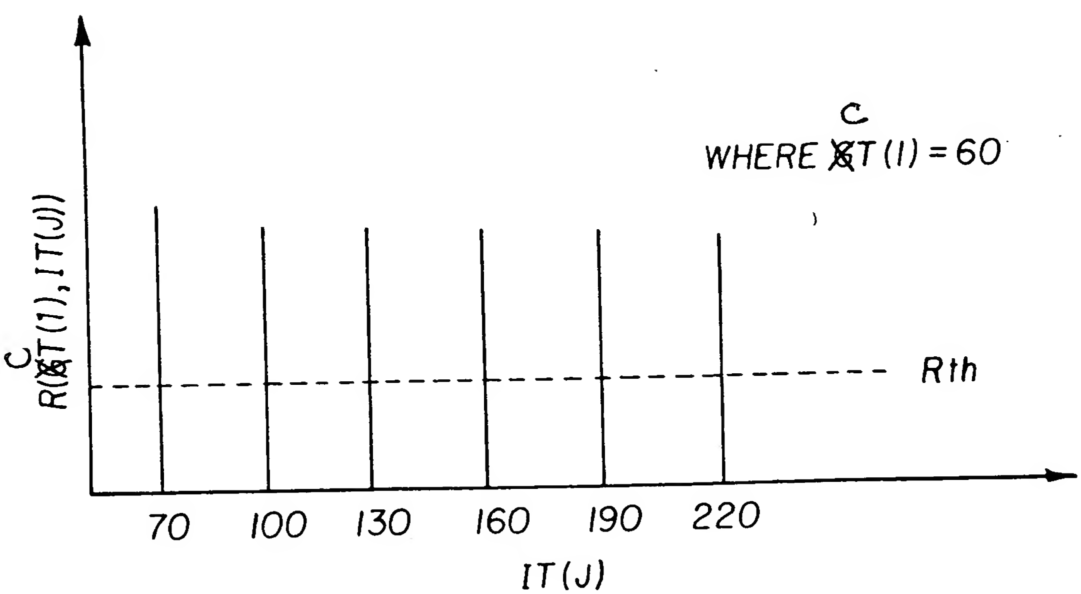
WHERE ~~X~~ C T(I)=60
R(~~X~~ C T(I), IT(J))
Rth
70
100
130
160
190
220
IT(J)

FIG. 4H

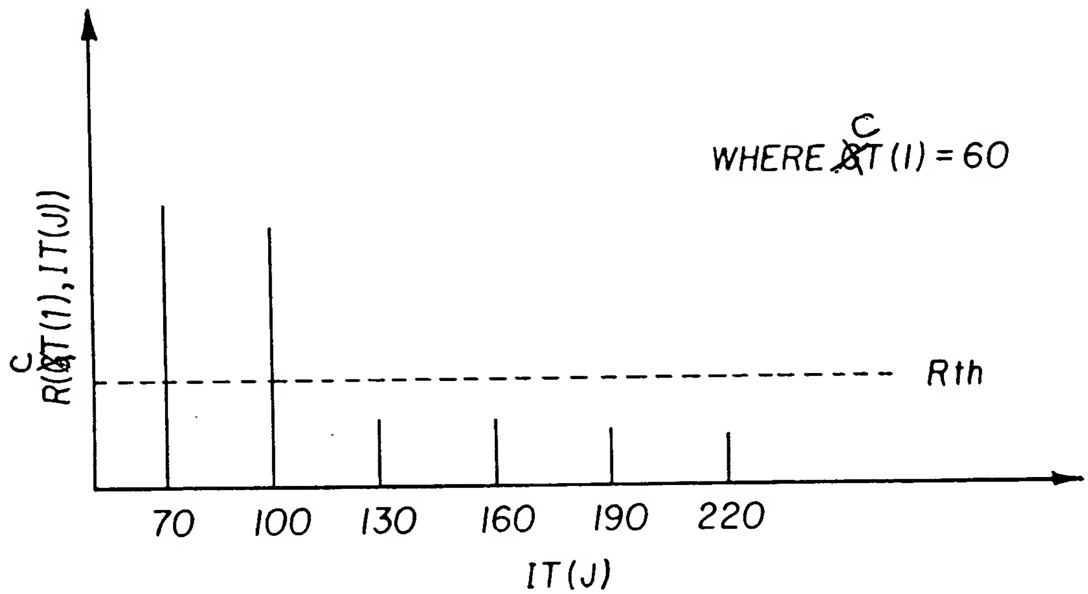

FIG. 4I